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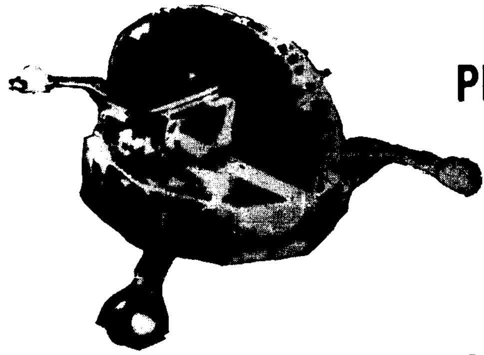

PROJECT: OSO-E and OSO-D

(OSO-E to be launched no earlier than March 8, 1967; OSO-D - 60-90 days later)

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NEWS NASA

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TWO OSO's SCHEDULED IN SERIES

Two more Orbiting Solar Observatories, OSO-E and -D, will be launched this spring by the National Aeronautics and Space Administration to study the Sun and its influence on the Earth's atmosphere.

OSO-E will be orbited by a Delta Launch Vehicle into a 350-mile circular orbit no earlier than March 8 from Cape Kennedy, Fla., and OSO-D will follow 60-90 days later. Each spacecraft will carry nine experiments. If successfully placed in orbit, OSO-E will become OSO-III and D will become OSO-IV.

The OSO program, now a series of eight approved satellites, is one of NASA's major efforts in solar physics. It is designed to provide continuous observations during the 11-year solar cycle.

The Sun's activity declines from a high point during the first nine years, then rapidly builds back to a high phase in the remaining two years. The period of maximum change is beginning now as the Sun goes from the minimum to maximum phase over the next two years.

A study of solar activity and its effect on Earth, aside from basic scientific interest, is necessary for a greater understanding of the space environment prior to manned flights to the Moon. Knowledge gained from OSO data will be especially useful in predicting solar flare, because it will provide warning of intense solar activity for astronauts on flight missions.

As it is the nearest star to Earth, the Sun also offers unique opportunities to gain more knowledge of our universe.

It is the only star in which man can directly observe features such as spots and flares, and the only one near enough to permit detailed study of its X-rays, gamma rays and radio emissions.

The Sun emits electromagnetic radiations of various wavelengths and energetic particles. On striking the Earth they produce circulation in the atmosphere. Lower atmosphere circulation produces long-range climatic effects resulting in weather changes.

Part of the solar radiation is absorbed or reflected by the upper atmosphere and this radiation -- X-ray and ultraviolet -- produces the region of great electron concentration called the ionsphere. Earlier OSO spacecraft noted rapid changes in the intensity of solar radiation in these wavelengths following a period of solar surface activity. Solar particle emission also varies greatly following solar flares. As yet we do not know why either of these conditions occur.

Of the total radiation spectrum emitted by the Sun, the Earth's atmosphere absorbs most of the ultraviolet and X-rays below the energy level of 3,000 angstroms. OSO spacecraft, operating above the atmosphere, are ideal research instruments for solar investigation.

OSO-E and -D, carrying nine experiments each, will study the structure, dynamics and chemical composition of the outer parts of the solar atmosphere through X-rays, visible and ultraviolet radiation.

OSO-D will carry a Solar Ultraviolet Scanning Spectrometer capable of transmitting a "picture" (digital numbered) of the Sun in the ultraviolet range. Then, via special communications facilities, the photo will be transmitted from the Earth receiving station directly to the experimenter. This is to provide the experimenter, for the first time, a chance to ask for another "picture," possibly in another wavelength, of a rapidly occurring solar event on the satellite's next orbit.

In addition, the OSO satellites will transmit information back to Earth on the proton-electron environment of the spacecraft and the Earth's night skyglow, a band of blue along the horizon, first seen by astronaut John Glenn in February 1962.

Other experiments include:

Earth Albedo -- Measurement of light energy reflected from the Earth's surface to give a better understanding of how and where heat is reflected from various parts of the planet.

Celestial Gamma-Ray -- Detection and identification of gamma rays of more than 100 million electron volts to learn their celestial distribution.

Extra-solar X-rays -- A survey to determine point and background sources of X-rays originating outside the solar system.

Cosmic Ray Charges -- Detection of energetic particles and their sources in the universe, including the Sun.

The first two OSO spacecraft were launched successfully from Cape Kennedy on Mar. 7, 1962 (OSO-I) and Feb. 3, 1965 (OSO-II). The third OSO, launched Aug. 25, 1965 failed to achieve orbit. Both OSO I and II surpassed their six-month design lifetimes and together provided about 4,000 hours of scientific information. OSO-I carried 13 experiments and OSO-II carried eight.

Like their predecessors, OSO-E and -D are built to aim their experiments at the Sun with a pointing accuracy of one minute of arc.

The basic OSO spacecraft is built in two sections, an upper sail-like structure which carries the primary pointing experiments and a nine-sided base section called the wheel. The wheel carries scanning experiments and equipment such as the batteries and telemetry system.

OSO is stabilized in orbit by the rotation of its wheel section. An automatic spin control system keeps it spinning about 30 rpm.

A sail control system keeps this portion of the spacecraft facing the Sun while an automatic pitch control system, using gas jets, maintains the spin axis of the entire spacecraft approximately perpendicular to the direction of the Sun.

Among improvements over previous OSO spacecraft is a torque coil to augment the automatic pitch control system. The coil, operated on ground command, generates a magnetic field which creates a torque on the spacecraft by reacting with the Earth's magnetic field. This reduces gas consumption and increases life expectancy.

An improved ground command system, for emergency control, will permit OSO-E to receive up to 94 different commands while OSO-D will be able to receive up to 140 commands. OSO I and II could receive 10 and 70 commands, respectively.

Experimenters will benefit from an improved device to determine the roll attitude of the spacecraft by sensing its position in relation to the Earth's magnetic field and Sun direction.

The OSO program is directed by Physics and Astronomy Programs, Office of Space Science and Applications, NASA Headquarters. Project management is under the Goddard Space Flight Center, Greenbelt, Md., which is also responsible for tracking and data acquisition and the Delta launch vehicle.

The OSO spacecraft are designed and built by Ball Brothers Research Corp., Boulder, Colo. Launch of the three-stage Delta is under the supervision of the Kennedy Space Center's Unmanned Launch Operations (ULO) and the Delta is built by Douglas Aircraft Co., Santa Monica, Calif.

END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS

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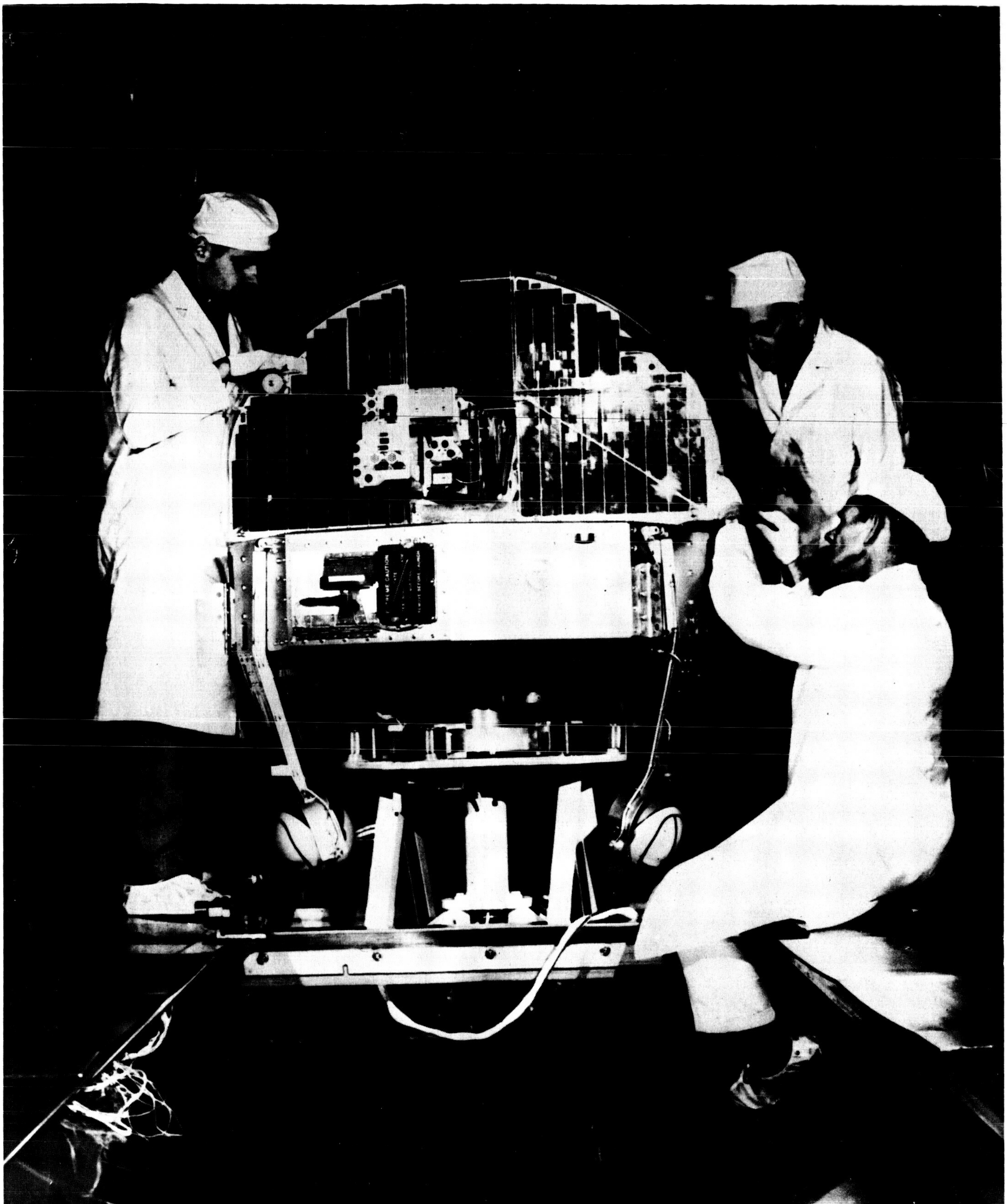

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OSO ACCOMPLISHMENTS

OSO-I observed more than 140 solar flares and sub-flares. It mapped gamma ray radiation in space, examined energetic particles in the Van Allen radiation belt and studied X-ray and gamma ray radiation from the Sun, and transmitted some 2,000 hours of scientific data to the Earth.

Its findings were especially significant in that they showed the wide discrepancies between solar activity above the Earth's atmosphere compared with observations made on Earth. OSO-I also confirmed the theory that solar plasma or wind emitted from the Sun reaches the Earth's atmosphere.

Scientific findings from OSO-I revealed that changes up to 400 percent occur in ultraviolet and X-ray emissions from the Sun during periods of increased solar activity. Further insights were gained about the composition and characteristics of the Sun including the presence of ionized helium and iron.

To date, more than 24 scientific papers have been published by the OSO-I experimenters and analysis of information information is continuing. On Sept. 7, 1962, OSO-I realized its life expectancy of six months but continued to send useful scientific information for more than one year.

Scientific information returned and analyzed so far by OSO-II shows that:

-- The brightness of the zodiacal light near the ecliptic pole is considerably less than originally thought;

-- There is no appreciable contribution to the zodiacal light from a local cloud of dust (dust particles in the atmosphere over the viewer);

-- There are no rapid changes in the brightness of the sky from above the airglow;

-- The majority of the airglow seen in the visible portion of the spectrum arises in a layer about 56 miles (90 kilometers) above the Earth.

-- Brightness and color of airglow change with weather conditions and the scale of the airglow is similar to the scale of a large meteorological system.

-- Lightning strikes more over land than water and some geographic regions appear to receive more than others.

On November 6, 1964, OSO-II was placed in a stowed mode of operation because the gas in its automatic pitch control system was almost depleted. At that time, the spacecraft had exceeded its life expectancy of six months by 50 percent.

Goddard project engineers turned the OSO-II back on, perhaps for the last time, June 1, 1966, and turned it off five days later. The additional engineering data proved especially valuable for determining life expectancy of instruments aboard the spacecraft. OSO-II transmitted about 1,980 hours of scientific data.

OSO-C

The OSO-C mission failed because the first two stages of the Delta Launch Vehicle performed well but the X-258 solid third stage ignited about five and one-half seconds prematurely.

A study of the failure indicated that the igniter squib in the third stage of the Delta Launch Vehicle was the most probable cause. Following the ignition signal from the second stage, the squib was programmed to delay the ignition of the third stage for six seconds. This delay did not occur.

This was the first failure of its kind in the 40 launches of the Delta.

OSO SPACECRAFT

The Sail & Wheel Structure

The sail structure is nearly semicircular with a radius of 22 inches. It is covered with 2,016 solar cells. Behind the solar cell panel are electronic and mechanical components to operate the sail.

The nine-inch-high wheel structure is made of aluminum alloy and consists of nine wedge-shaped compartments each with 1,000 cubic inches of space. Five compartments hold experiments, the remaining four house the electronic controls, batteries, telemetry and radio-command equipment.

In the orbit configuration, three 30-inch arms extend from the wheel section at 120-degree intervals. At the end of each arm is mounted a six-inch diameter sphere containing nitrogen gas under an initial pressure of 3,000 pounds per square inch.

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Automatic Spin Control System

Initial spin-up to 120 rpm is imparted to the spacecraft during the latter stages of powered flight. The spin rate is reduced to about 100 rpm when the spacecraft's three arms are extended just after third stage burn-out while the OSO is still attached to this stage. A signal from the spacecraft's timer system actuates the automatic spin control system on the OSO to de-spin the spacecraft to approximately 30 rpm and maintain it at this rate.

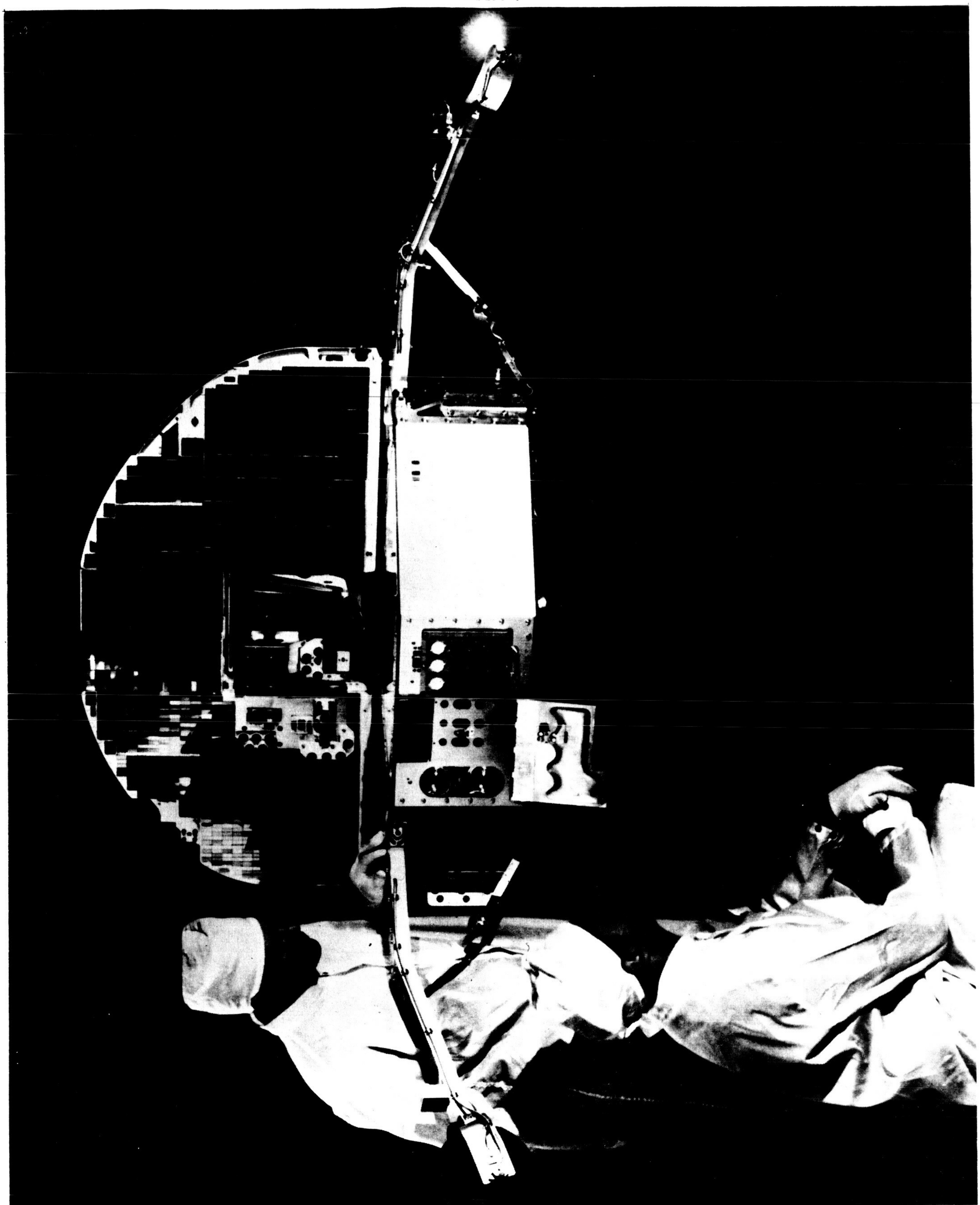
The automatic de-spin system consists of a set of silicon photoelectric "eyes" on the rim of the wheel section, associated electronics, and three nitrogen gas storage spheres located on the ends of the spacecraft's arms. The "eyes" count the frequency at which they "see" the sun. If the rate exceeds 41 per minute, gas is released through tiny jets in the storage bottles to slow down the wheel. If the wheel's spin rate should drop below 26 rpm, jets on the opposite side of the supply bottles are fired to speed up the wheel.

Sail Control System

While the OSO is in darkness, the sail section rotates with the wheel. Each time the spacecraft moves from behind the Earth into view of the Sun, the sail locks onto the Sun.

Coarse correction of the sail position is provided by two pairs of silicon photo-detector "eyes" which control a servo-motor designed to drive the sail in the opposite direction of the spinning wheel. A pair of the "eyes" is located on each side of the sail section so that all four "eyes" have a 360-degree field of view. Each "eye" is masked so that it has an individual 90-degree field of view. When the pair of "eyes" on the Sun-facing side of the sail sense that they have the full disk of the Sun centered in their "sight," the servo-motor holds the sail facing the Sun within three degrees.

Fine correction of the sail's two pointing experiments within one minute of arc in azimuth and elevation is maintained by two pairs of silicon photodetector "eyes" located on the viewing end of the experiments. One pair of these "eyes" controls the same servo-motor used for sail de-spin to provide fine azimuth pointing of the experiments. The other pair of "eyes" controls a separate servo-motor for elevation pointing.



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Automatic Pitch Control System

Any pitching motion of the OSO spacecraft, either forward or back, must be corrected if the onboard experiments are to be in a proper position to view the Sun.

Coarse control in pitch is provided by an automatic control system which maintains the spacecraft spin axis perpendicular to the direction of the Sun within three and a half degrees either up or down.

This system essentially consists of a pair of silicon photo-electric "eyes" located on the Sun-side of the sail, the necessary electronics, and a nitrogen gas storage bottle located inside the sail section. Two gas jets are connected to the storage bottle. These are located on top of the sail, one on each side of the spin axis of the spacecraft.

Whenever the "eyes" sense that the spacecraft pitches forward or backward so that the spin axis is less than three degrees from perpendicular to the direction of the Sun, gas is made to flow through one of the jet exhausts. This applies the proper force to correct for the error in pitch.

The automatic pitch control system, which can be backed up by command control from the ground, is capable of precessing the entire spacecraft.

Magnetic Torque Coil

A magnetic torque coil is used aboard the OSO to help minimize pitching motions of the spacecraft. Wound around the inside hub of the wheel section, it can be energized in three basic modes by command from the ground. Power to the coil can be turned on or off, it can be changed from full to half-power, and the polarity of the coil can be reversed.

When energized, the coil produces a torquing force which is perpendicular to the coil and which tends to line up perpendicularly with the Earth's magnetic field. Since the force also coincides with the spin axis of the spacecraft, it helps to minimize any pitching motion of the spacecraft.

Aspect Monitoring System

The roll aspect of the OSO attitude must be determined for the benefit of the experimenters, particularly those with experiments on the wheel section. For this purpose, OSO is equipped with an aspect monitoring system which measures the spacecraft's roll position in relation to the direction of the Sun.

This system uses a magnetometer to sense the spacecraft's position relative to a plane in the Earth's magnetic field. Simultaneously, the system produces time pulses which indicate points along the magnetic plane at which the spacecraft sees the Sun.

Information from the aspect monitoring system, along with information on the spacecraft's pitch angle, is compared to known values of the Earth's magnetic field with a ground-based computer to determine the roll angle of the OSO at any given time during its orbit.

Onboard Communications System

The communications system onboard the OSO provides its sole link to the ground once the spacecraft has left the Earth. This system is designed to receive and process command signals, record experiment data, and transmit experiment and spacecraft data to the ground.

A total of 94 different commands can be accepted in digital form by the OSO-E and 140 similar commands can be accepted by OSO-D. These are received onboard the spacecraft by two command receivers which operate on a continuous basis for protection against a single receiver failure. Both receivers are located in the wheel section of the spacecraft.

The output from the command receivers is fed into three decoders for command execution. Capable of decoding a maximum of 47 commands each, the three decoders require individual address commands. Output signals from the decoders actuate latching-type relays and transistor switches in executing the commands.

Two of the decoders are located in the wheel section to process commands independently for this part of the spacecraft. Commands intended for the sail section are processed by the third decoder located in the sail. Command signals for the sail section are received through the receivers in the wheel section and relayed to the sail section by means of slip rings which are rotating electrical contacts.

As OSO orbits the Earth, it will transmit data in real-time from its scientific experiments to the ground while simultaneously recording the same data with an onboard tape recorder. The recorder operates throughout the spacecraft's orbital period of about 95 minutes, recording data at the rate of 400 bits of digital information per second.

The spacecraft is commanded, once each orbit, to play back at the high speed rate of 7200 bits per second. This is 18 times the record speed and requires only about five and one-half minutes.

Upon completion of the playback period, the tape recorder automatically reverts to the record mode and the spacecraft resumes transmitting real-time data.

Spacecraft Power System

During the time OSO spends in the sunlight, the spacecraft requires about 26 watts of electric power including 13 watts for spacecraft systems and 13 watts for experiments. Approximately 10 watts are required for night-time use.

Electrical energy for OSO is supplied by solar cells. This energy not only powers the spacecraft while it is in the sunlight but simultaneously charges the batteries which provide power for operation at night.

OSO has 2,016 N/P solar cells attached to the Sun-facing side of the spacecraft's sail section. This solar cell array, consisting of 36 parallel strings of 56 cells each, has a total surface area of 4.0 square feet. A maximum of 38 watts of electric power can be provided with this array.

The N/P (N-on-P) solar cell is simply a slice of silicon crystal about 15 thousandths of an inch thick which has phosphor impurities diffused into the top surface and boron impurities diffused into the bottom surface. This design gives the crystal a negative region at the top and a positive region at the bottom. Electrons are made to flow between these two regions when the cell is exposed to sunlight, thereby providing electric power. N/P solar cells are more resistant to space radiation than the P/N solar cells previously used on orbiting spacecraft.

The prime battery pack consists of 42 rechargeable nickel-cadmium type F cells. Voltage for the battery pack ranges from 16.2, (an undercharge condition) to 22 volts when the pack is fully charged. When the battery voltage drops to 16.2, an under-voltage switch in the spacecraft's power system removes power from most of the spacecraft systems. This safety switch returns power to the affected systems only when the charge is up to 19 volts.

The under-voltage switch does not remove power from the receiver and decoder systems of the spacecraft's wheel section or from the launch sequence timer. Power is supplied continuously to the receivers and decoders so that the spacecraft can be commanded during any under-voltage conditions. The under-voltage switch can be bypassed by a relay upon ground command if so desired.

The OSO power sub-system also is equipped with a day-night switch which automatically cuts off certain systems to conserve power when the spacecraft is in the dark portion of the orbit. Signals from solar-sensing detectors on the rim of the spacecraft wheel actuate the switch which then turns off the pointed experiments, certain wheel experiments, the pointing-control system and the automatic spin-and-pitch control systems. These systems are turned back on again by the day-night switch when the spacecraft emerges into the sunlight from behind the Earth. Some experiments operate during the entire orbit.

OSO-E EXPERIMENTS

The experiments carried by OSO-E are spare units originally designed for back-up use in developing the OSO-C. They are flight-worthy units chosen for their potential to provide answers to some of the more pressing questions on the nature of solar emissions. In basic terms, these experiments are intended to map the occurrence and energy of solar radiation.

Of the nine experiments carried by the new observatory, two will be pointed at the Sun from the sail portion of the spacecraft. The remaining seven experiments need not be oriented toward the Sun continuously. These are located in the rotating wheel section.

Pointed Experiments

Ultraviolet Scanning Monochromator

This experiment, provided by the Air Force Cambridge Research Laboratory, Cambridge, Mass., is designed to investigate the effect of solar ultraviolet radiation on the Earth's ionosphere. It is an advanced version of similar devices flown earlier on sounding rockets. Its range of coverage will be about 225 to 1,300 angstroms. The device weighs 39 pounds and operates on 3.2 watts of power.

Solar Spectrometer

Provided by the NASA Goddard Space Flight Center, this spectrometer is a combination of five instruments, four of them designed to measure solar X-rays in various wavelengths from one to 400 angstroms. Each of the four instruments will scan the Sun at various pre-established speeds.

When the fifth instrument observes an excess of X-ray flux caused by a solar event, it will override operation of the other four instruments and cause them to operate at their highest scanning speeds. This will permit the instruments to obtain higher time resolution of changes of solar flux caused by the solar event.

Like the other pointed experiment, the Goddard spectrometer is controlled by ground command, making it one of the most complicated scientific satellite devices so controlled. The experiment weighs 38 pounds and operates on an average power of 2.75 watts.

OSO-E Experiments

Wheel Experiments

Thermal Radiation Emissivity Detector

This experiment from the NASA Ames Research Center, Mountain View, Cal., is being conducted to support the Apollo manned Moon landing program. It is a relatively simple experiment involving 12 special coatings to measure the long-term effects of the space environment on spacecraft surfaces. This is the same type of experiment flown by Ames on OSO II. It weighs two pounds and uses two watts of power.

Earth Albedo Telescopes

This instrument package, weighing almost 21 pounds, was provided by Ames too. It consists of six telescopes. Its purpose is to measure the light energy reflected from the Earth's surface - the Earth's albedo. Operating in an angstrom range from 3,200 to 7,800, the telescopes are expected to give scientists a better insight into the various differences of Earth-reflected energy since this energy varies greatly over water and cloud cover areas. It uses 0.5 watts of power.

Direction Radiometer Telescopes

The third Ames experiment consists of directionally sensitive radiometer telescopes, designed to extend the albedo experiment measurements into the far infrared range up to 30 microns. It consists of two parabolic mirrors with associated detectors. The device weighs slightly more than five pounds and uses 0.5 watts of power.

Celestial Gamma-Ray Detector

Provided by the Massachusetts Institute of Technology, this 90-pound device is the heaviest experiment carried onboard OSO-E. It occupies two complete compartments in the wheel section. It is an advanced version of a device first flown by Explorer XI in April, 1961. Its purpose is to detect and identify gamma rays of energy greater than 100 million electron volts and determine their celestial distribution. This information should extend our understanding of the distribution of these rays and help in the interpretation of data already obtained from earlier satellite flights.

When a gamma ray enters the device, its normal searching operation is automatically changed to analyze the ray. After the analysis process, the experiment returns to its normal operating mode until another gamma ray is encountered. Changes in operating procedures of the device are controlled by ground command. It uses one watt of power.

OSO-E Experiments

Solar X-Ray Detector

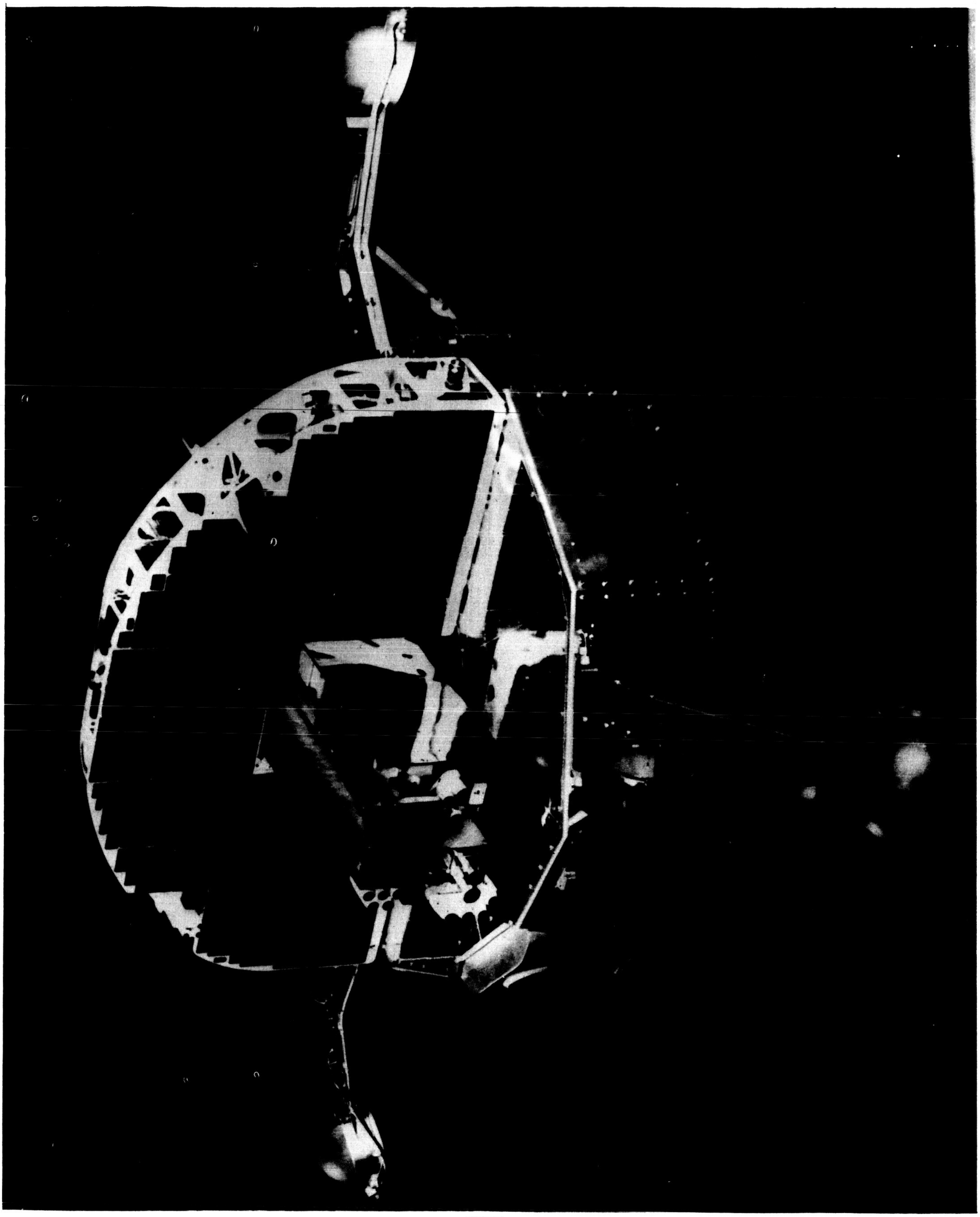
Designed to measure the intensity of solar X-rays in the 8-12 angstrom range, this device, provided by the University of Michigan, Ann Arbor, weighs six pounds and uses 0.8 watts of power. Data obtained from the experiment will complement data obtained by the Goddard X-ray Experiment. The instrument operates in both the high and low sensitivity ranges and switches automatically from one range or frequency to another when the X-ray flux reaches a pre-established level. Measurements of this type over a long period of the solar cycle are needed to establish a baseline for defining the total energy output from the Sun in this particular range.

Cosmic Ray Charge Spectrum Detector

The University of Rochester, Rochester, N. Y., has provided a 17-pound detector designed to map the sky, including the Sun, and detect energetic particles penetrating the experiment from sources throughout the universe. The experiment can discriminate between particles and gamma rays and, operating in its primary data acquisition mode, it can examine different sequential positions in the sky. It uses 0.7 watts of power.

Solar X-ray Telescope

This experiment, provided by the University of California, San Diego, will measure the intensity, energy and directional properties of X-rays in the 7000-190,000-electron volt range. (This corresponds to an angstrom range of 1.7 to 0.065.) It consists of a detector system of photomultipliers. Anti-coincidence shielding and a self-contained aspect system provide X-ray directional data. The instrument package weighs slightly more than 13 pounds and uses 0.5 watts of power.



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OSO-D EXPERIMENTS

The OSO-D also carries nine experiments. Three of these are located on the sail portion of the spacecraft and will be pointed at the Sun. The remaining six experiments are located in compartments of the nine-sided rotating wheel section and scan the Sun every two seconds.

Pointed Experiments

Solar X-ray Telescope

This experiment is provided by American Science and Engineering, Inc., Cambridge, Mass. It will obtain good resolution x-ray photographs of the Sun in various wavelengths in periods of both solar quiescence and activity. The wavelengths ranges are 3-8 angstroms, 8-20 angstroms and 20-50 angstroms.

Analyses of these data will yield information on electron and ion densities in the corona and on the processes involved in solar flares.

This instrument weighs about 25 pounds and operates on 1.5 watts of power.

X-ray Spectrometer

Provided by the U.S. Naval Research Laboratory, Washington, D.C., this experiment is designed to determine spectrally the difference in the make-up of the Sun in flare and non-flare periods in the region of one to eight angstroms. Further, it will be used to distinguish between thermal and non-thermal mechanisms in the x-ray emission process for this region. This instrument is designed to continue the investigation first started with a similar instrument on the OSO II.

This instrument weighs about 25 pounds and operates on 1.25 watts of power.

Solar Ultraviolet Scanning Spectrometer

This experiment was developed by the Harvard College Observatory, Cambridge, Mass., and is similar to a Harvard experiment on OSO II. It is designed to scan a wavelength region of the solar ultraviolet spectrum between 300 and 1,300 angstroms.

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OSO-D Experiments

Upon command, the instrument will set at any wavelength within its range and use the observatory's capability for scanning in a back and forth motion to construct an image of the Sun at the desired wavelength. Due to the detail-scan coverage time of the Sun (4.25 minutes), these photos will have a moderately good time resolution for rapidly occurring solar events.

This spectrometer weighs about 37 pounds and uses about two watts of power.

Due to the versatility of this experiment, a special data line has been established to link Harvard with the Goddard Space Flight Center in Greenbelt, Md., for "real time" acquisition of the instrument's data. Information from OSO-D experiments will be sent to Goddard by landline from the STADAN facility at Ft. Myers, Fla., where it will be read out of the spacecraft after each orbit. Data from the Harvard experiment will be recovered and computer processed at Goddard.

By this means, the Harvard experimenters can analyze their data and elect to have their experiment commanded to change its mode of operation during each orbit to observe a particular solar occurrence.

Wheel Experiments

Extrasolar X-ray Detector

This experiment is provided by American Science and Engineering, Inc., Cambridge, Mass. It is designed to survey the night sky for cosmic sources of x-radiation with energies from one-half to 30 kev. Both point sources of radiation as well as a general background of x-rays originating in the celestial sphere are expected to be revealed by the surveys with this instrument.

Information from such a survey will prove useful for determining extra-solar sources of x-radiation and secondly their effects upon future manned space travel.

Weighing about 25 pounds, this instrument requires almost one watt of power for its operation.

OSO-D Experiments

Broadband Solar X-ray Detector

Provided by the University College, London, this experiment is designed to detect solar x-rays in the wavelength ranges of 1-20 angstroms and 44-75 angstroms.

Study of the radiation in this region of the spectrum under both quiet and active solar conditions can lead to a better understanding of the state of the solar corona.

This instrument weighs about 25 pounds and uses a little less than one watt of power for operation.

Monochromator

This experiment is provided by the University College, London, England. It is designed to monitor the total flux of helium II radiation at the 304-angstrom energy level with a time resolution of about two seconds. In addition, this instrument can be commanded to sample hydrogen radiation at the 1,216-angstrom level.

Such information will be useful in helping to determine how changes in the helium radiation from the Sun affect the Earth's ionosphere.

Weighing 26 pounds, this instrument requires 0.5 watt of power for operation.

Proton-Electron Detector

Provided by the University of California, Lawrence Radiation Laboratory, Livermore, Cal., this experiment will detect the protons and electrons encountered by the observatory. It will measure the energy dependence and the angular distribution of these particles relative to the local magnetic field.

Information collected with this instrument will be used to study the buildup and loss mechanisms of the radiation trapped in the local magnetic field. Of particular interest is the effect of longitudinal variations in the Earth's magnetic field as well as the effect of solar cycle variations on the proton population.

This experiment weighs 35 pounds and requires one watt of power for operation.

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OSO-D Experiments

Solar X-ray Detector

This experiment is provided by the U.S. Naval Research Laboratory, Washington, D.C. It will measure the energy input to the Earth's atmosphere in the spectral bands of 0.1-1.6 angstroms, 0.5-3.0 angstroms, 2-8 angstroms and 8-16 angstroms.

These measurements will provide a good characterization of solar emission. They will provide a set of x-ray indices against which other geophysical parameters can be correlated. Such indices will indicate time variations in solar events and will provide a method of classifying solar events more quantitatively than the present type of solar activity classifications.

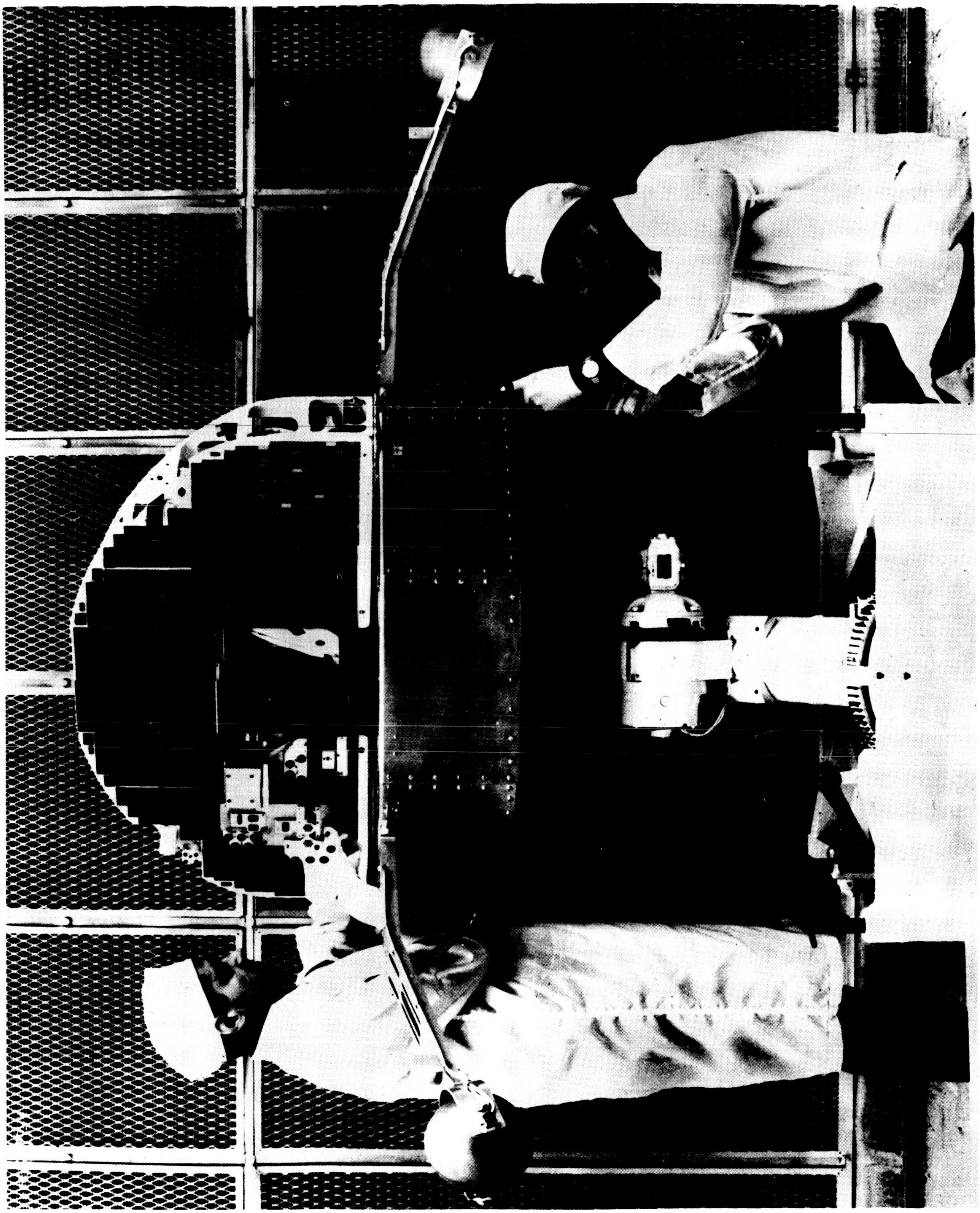
This experiment weighs about eight pounds and uses two watts of power for its operation.

Night Skyglow Detector

The U.S. Naval Research Laboratory provided this experiment to scan and record Lyman-alpha night skyglow which results from scattering of the solar hydrogen in the Earth's corona. The energy range of this instrument extends from 1,050 to 1,350 angstroms.

Information collected with this instrument will help provide a better understanding of how hydrogen emissions from the Sun are absorbed in the Earth's upper atmosphere.

This instrument weighs 24 pounds and uses one watt of power.



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ORBITING SOLAR OBSERVATORY

OSO-E and OSO-D

Spacecraft

Weight:	About 627 pounds (252 pounds of scientific instruments and associated equipment).
Shape:	Base section: nine-sided wheel with three arms carrying spin control gas supply; top section: fan-shaped with pointing instrumentation.
Size:	Wheel diameter: 44 inches, increased to 92 inches with three arms extended. Overall height: 38 inches.
Lifetime:	Designed for six months useful lifetime.

Launch Phase

Site:	Complex 17, Cape Kennedy, Eastern Test Range.
Vehicle:	Three-stage Delta Launch Vehicle.
Azimuth:	108 degrees.
Orbital plan:	Circular orbit about 350 miles altitude.
	Period: About 95 minutes. Inclination: 33 degrees to the equator.

Power Subsystem

Solar Power Supply:	Maximum 38 watts provided by 4.0 square feet of N/P solar cells arranged in 36 parallel strings of 56 cells each on Sun-facing side of sail section.
Typical maximum load:	About 26 watts including 13 watts for experiments. About 10 watts required at night.

Delta Launch Vehicle

Successful orbiting of OSO-E by the Delta will give this vehicle a record of 42 spacecraft orbited out of 46 launches.

Delta has the following characterisitics:

Overall length:	90 feet
Maximum diameter:	8 feet
Nominal liftoff weight:	114,000 pounds

First Stage: Douglas Aircraft Co. Thor

Burning time:	About 2 minutes 25 seconds
Thrust:	172,000 pounds
Propellants:	Kerosene and liquid oxygen
Weight:	Over 50 tons

Second Stage: Aerojet-General Corp., AJ-10-118A propulsion system.

Burning time:	About 2 minutes 40 seconds
Thrust:	7550 pounds
Propellants:	Liquid UDMH and Red Fuming Nitric Acid
Weight:	Two and one-half tons

Third Stage: Allegany Ballistics Laboratory X-258

Burning time:	23 sec.
Thrust:	About 5,700 pounds
Propellants:	Solid Propellants
Weight:	About 573 pounds
Length:	About 61 inches
Diameter:	18 inches

During first and second stage powered flight, the Western Electric Co. radio guidance system is used for inflight trajectory corrections. It also commands second-stage cutoff when the desired position, velocity and attitude have been achieved.

Launch Sequence

The first stage of the Delta launch vehicle is ignited and liftoff occurs. Upon completing its approximate 2.5 minute burn, the first stage rocket separates. At this point, the second stage rocket ignites and burns for about 2.75 minutes.

The nose fairing is jettisoned some 30 seconds after second stage ignition. It is this fairing which protects the OSO and the third stage rocket along with its instrumentation from aerodynamic heating in flight through the atmosphere.

After second stage burnout, the launch vehicle begins a coast period of approximately six minutes. About two seconds before separation from the second stage, the third stage and the OSO spacecraft are spun up to about 120 rpm. This is accomplished by means of small rockets mounted on a spin table located between the second and third stages.

When the second and third stages separate, the third stage burns for about 23 seconds to reach orbital velocity of about 17,000 mph. Both the third stage and the OSO go into orbit at this point.

Upon completion of third stage burnout, but before the OSO separates from this stage, the three arms on the spacecraft extend. This slows the spin rate of the OSO to about 100 rpm. After separation from the third stage, the de-spin system on OSO is actuated by a signal from the spacecraft timer and the spacecraft spin rate is slowed to the desired 30 rpm and maintained at this rate. About 20 minutes after launch, OSO acquires the Sun.

MAJOR LAUNCH EVENTS

(All times approximate)

TIME (Minutes & Seconds)	EVENT	ALTITUDE (miles)
0:00	Ignition & lift-off	---
2:28	Main engine cut-off (MECO)	50
2:33	Stage II ignition and Stage I-II separation	54
3:03	Jettison spacecraft Fairing	82
5:06	Stage II cut-off (SECO)	180
5:07	Begin 6-minute coast	180
11:10	End 6 minute coast phase	295
11:11	Fire rockets on spin table between Stage II & III	299
11:13	Stage II-III separation	299
11:26	Stage III ignition	299
11:49	Stage III burn-out	300
12:50	OSO arms erected	300
13:27	Stage III-OSO-E1 separation	300
20:00	OSO acquires Sun	300

TRACKING, DATA ACQUISITION AND COMMAND STATIONS

All of the ground stations used to track, acquire data or command the OSO spacecraft are part of the NASA's Space Tracking and Data Acquisition Network (STADAN), operated by the Goddard Space Flight Center.

Tracking

The following STADAN stations will track the spacecraft: Orroral Valley, Canberra, Australia; Fort Myers, Fla., Quito, Ecquador; Lima, Peru; Santiago, Chile; Johannesburg, South Africa; and Mojave, Calif.

Data Acquisition

The following STADAN stations will acquire data from the OSO: Orroral Valley, Australia; Fort Myers, Fla.; Rosman, North Carolina; Quito, Ecuador; Lima, Peru; and Santiago, Chile.

Upon command, the spacecraft tape recorder will be read out at least once per orbit. The recorder has a 100-minute data storage capability but is played back in about 5.5 minutes at 18 times the recorded rate. Both the tape recorder playback data and real-time data from the spacecraft will be recorded by the ground stations.

Normal readout of the recorder will occur once in each orbit by one of the stations in North Carolina, Florida or South America. If necessary, several of these stations will be able to record the data simultaneously. The three remaining stations in Africa, Australia and California will command data from the spacecraft twice a week to maintain an operational capability with the spacecraft.

Command

All commands for the OSO are initiated in the OSO Control Center at Goddard but ar actually generated at one of the field stations. The more complex commands are generated at the Fort Myers, or the Rosman station, which is used as a back-up. Tape recorder commands are also generated at one of the remaining stations. This arrangement provides for flexible control of the spacecraft and its experiment operating modes.

OSO TEAM

NASA HEADQUARTERS

Dr. Homer E. Newell	Associate Administrator for Space Science and Applications
Jesse L. Mitchell	Director, Physics and Astronomy Programs, OSSA
Dixon L. Forsythe	Program Manager for Solar Observatories
E. B. Stubbs	OSO Program Engineer
Dr. H. Glaser	OSO Program Scientist
Vincent L. Johnson	Director, Launch Vehicle and Propulsion Programs
Robert Manville	Delta Program Manager

GODDARD SPACE FLIGHT CENTER

Dr. John F. Clark	Director
Dr. John W. Townsend, Jr.	Deputy Director
Robert E. Bourdeau	Assistant Director for Projects
Laurence T. Hogarth	OSO Project Manager
T. E. Ryan	Tracking & Data Systems Manager
William R. Schindler	Delta Project Manager

BALL BROTHERS RESEARCH CORP.

Dr. R. C. Mercure	Director
R. Marsh	OSO Project Manager

DOUGLAS AIRCRAFT COMPANY

Marcus F. Cooper	Director, Florida Test Center, Cape Kennedy
J. Kline	Delta Systems Engineer

EXPERIMENTERS (OSO-E)

Pointed:

Air Force Cambridge Research Lab., Cambridge, Mass.	Ultraviolet Scanning Monochromator H. E. Hinteregger
NASA Goddard Space Flight Center, Greenbelt, Md.	Solar Spectrometer Werner M. Neupert

Wheel:

Ames Research Center Mountain View, Cal.	Thermal Radiation Emissivity Detector C. B. Neel
Ames Research Center	Earth Albedo Telescopes C. B. Neel
Ames Research Center	Directional Radiometer Telescopes C. B. Neel
University of California, San Diego	Solar X-ray Telescope L. E. Peterson
Massachusetts Institute of Technology, Cambridge, Mass.	Celestial Gamma-Ray Detector W. L. Kraushaar
University of Michigan, Ann Arbor	Solar X-Ray Detector R. G. Teske
University of Rochester, Rochester, N.Y.	Cosmic Ray Charge Spectrum Detector M. F. Kaplon

EXPERIMENTERS (OSO-D)

Pointed:

American Science and Engineering, Inc. Cambridge, Mass.	Solar X-ray Telescope R. Giacconi
U. S. Naval Research Laboratory, Wash., D.C.	X-ray Spectrometer H. A. Friedman
Harvard University, Cambridge, Mass.	Solar UV Spectrometer L. Goldberg

Wheel:

American Science and Engineering, Inc., Cambridge, Mass.	Extrasolar X-ray Detector R. Giacconi
University College, London, England	Broadband Solar X-ray Detector R. L. F. Boyd
University College, London	Monochromator R. L. F. Boyd
Lawrence Radiation Lab. U. of Cal., Livermore, Cal.	Proton-Electron Detector J. Waggoner
U. S. Naval Research Laboratory, Wash., D.C.	Solar X-ray Detector T. A. Chubb
U. S. Naval Research Laboratory	Night Skyglow Detector P. W. Mange

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